TITLE:	ADVANCED DIAGNOSTIC TECHNIQUES FOR THREE PHASE BUBBLE COLUMN REACTORS
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ABSTRACT

OBJECTIVE

The overall objective of this collaborative project between Washington University, Ohio State University and Air Products and Chemicals is to advance the knowledge and understanding of the hydrodynamics of Fischer-Tropsch (FT) slurry bubble column reactors (SBCR).

ACCOMPLISHMENTS TO DATE

During this present period the following has been accomplished at Washington University and Ohio State University:

1. Data processing and analysis of the performed computer automated radioactive particle tracking (CARPT) and computed tomography (CT) experiments using air-water-glass beads (150 μm) system in high pressure 6" column have been performed. The effects of reactor pressure (0.1 MPa (14.7 psi), 0.4 MPa (58 psi), 1.0 MPa (145 psi)) and superficial gas velocities (8 cm/s (bubbly flow regime) and 45 cm/s (churn turbulent flow regime)) have been investigated.
2. Dynamic pressure drop and overall gas holdup measurements at the same conditions of CARPT and CT experiments using air-water-glass beads (150 μm) have been performed in the high pressure 6" column equipped with windows and ports. Pressure drop measurements are needed at the same level and conditions of the performed CT and CARPT experiments, for the developed methodology that combines CT, CARPT and ΔP to measure in a noninvasive manner the radial and axial distribution of the three phases in SBRC. However, it was found that the results obtained by this methodology are not reliable as it is very sensitive to the pressure drop measurements and the tracer particle occurances obtained by CARPT do not properly represent the solids concentration (loading) distribution.
3. A new methodology has been developed that combines overall gas holdup (measured by the change in dynamic height) and the assumption of uniform radial solids loading with the CT measurements to evaluate gas, liquid and solids holdups distribution. The method has been implemented on the CT measurements using air-water-glass beads (150 μm) system.
4. CT experiments using Therminol LY heat transfer fluid that mimic FT waxes have been performed. The system used was air-Therminol-glass beads (150 μm) (20% by weight solids loading (9% by

volume)) at pressure range of 0.1 MPa to 1.0 MPa and superficial gas velocity range of 8 cm/s to 25 cm/s. Work is in progress to process the data and perform sensitivity analysis to the parameters used in CT reconstruction.

5. The effects of reactor pressure (0.1, 0.4, 1.0 MPa), solids loadings (20% by weight (9% by volume) and 40% by weight) and superficial gas velocity (up to 25 cm/s) on overall gas holdup (measured by the change in dynamic height), flow field and turbulent parameters (measured by laser Doppler velocimetry (LDV)), flow regime transition (measured by dynamic pressure transducer), bubble size and bubble rise velocity (measured by optical probe) in 5.1 cm (2 inch) slurry bubble column have been investigated using Norpar 15 fluid that mimic at room temperature the Fischer-Tropsch waxes at FT reaction conditions of high pressure and temperature. The slurry system used was Nitrogen-Norpar 15-glass beads (150 μm).
6. To improve the design and scale-up of bubble column, a new correlation based on neural network approach to predict the overall gas in bubble column has been under development (5500 data points obtained from literature and from our previous work have been used in this work).

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

The work executed in this project represents a complimentary effort to the DOE program on the hydrodynamics of slurry bubbles in conjunction with the operation of the Advanced Fuels Development Unit (AFDU) in LaPorte, Texas, operated by Air Products and Chemicals.

PLANS FOR THE COMING YEAR (NO-COST EXTENSION)

- Completion of CARPT experiments using air-Thernimol Ly-glass beads (150 mm) to investigate the effect of reactor pressure and superficial gas velocity on the flow field and turbulent parameters.
- Completion of the data processing and analysis of CT and CARPT experiments.
- Completion of the development of the neural network based correlation for the prediction of overall gas holdup.
- Writing the final report.

ARTICLES, PRESENTATIONS AND STUDENT SUPPORT

Presentations

1. Wu, A. Shaikh, M.H. Al-Dahhan, Prediction of mass transfer coefficient in bubble column at high pressure operation", AIChE 2001 Annual Meeting, Reno, Nevada, 358a, 2001.
2. A. Shaikh, M.H. Al-Dahhan, "Development of neural network based correlation for overall gas holdup in bubble column reactors", AIChE 2001 Annual Meeting, Reno, Nevada, 358n, 2001.
3. A. Shaikh, M.H. Al-Dahhan, "Prediction of overall gas holdup in bubble column reactor via neural network correlation, AIChE, 2002 Spring National Meeting, New Orleans, Louisiana, 114C, 2002.

Students Supported Under This Grant

- A Shaikh and N. Rados (Ph.D.) and David Newton (undergraduate) students in Chemical Engineering, Washington University.
- R. Lau, K. Vuong, Q. Marashdeh, R. Ahmed, graduate students (Ph.D.) in Chemical Engineering, Ohio State University.